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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/614,051
Filing Date: July 08, 2003
Appellant(s): LIN ET AL.

John Harrity
For Appellant

EXAMINER'S ANSWER

This examiner's answer is in response to the appeal brief filed 5/24/05 in conjunction with the supplemental brief filed 8/15/05. The appeal brief filed 5/24/05 was defective as lacking an evidence appendix and a related proceedings appendix. Appellant filed a supplemental appeal brief on 8/15/05 that included the previously missing appendices. The supplemental appeal brief did not include a complete copy of the appeal brief. However, the supplemental appeal brief of 8/15/05 taken in conjunction with the appeal brief of 5/24/05 constitutes a complete brief in compliance with 37 CFR 41.37.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

No amendment after final has been filed.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

The following is a listing of the evidence (e.g., patents, publications, Official Notice, and admitted prior art) relied upon in the rejection of claims under appeal.

- Wu et al. (USPUB 2004/0048424), previously cited;
- Frenette et at. (USPAT 5,770,490), previously cited;
- Wolf et al. ("Silicon Processing for the VLSI Era: Volume 1 - Process Technology," Lattice Press, copyright 1986, Pp. 263-264), presented herein as evidence.

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 13 – 14 and 20 are rejected under 35 U.S.C. 102(e) as being anticipated by Wu et al. (USPUB 2004/0048424, Wu).

With regard to claim 13, Wu discloses in figures 6 – 10 a method for doping fin structures in FinFET devices. Wu discloses in figure7b and paragraph [0021] forming a first glass layer (10) on the fin structures of a first area (6) and a second area (5). Wu discloses in figure 7b and paragraph [0021] removing the first glass layer from the second area. Wu discloses in figure 8b and paragraph [0022] forming a second glass layer (12) on the fin structures of the first area and the second area. Wu discloses in figure 9b and paragraph [0023] annealing the first area and the second area to dope the fin structures of the first area and the second area.

With regard to claim 14, Wu discloses in figure 10 and paragraph [0024] removing the second glass layer from the first area and the second area and removing the first glass layer from the first area.

With regard to claim 20, Wu discloses in figure 7b and paragraph [0021] wherein the forming a first glass layer includes forming the first glass layer directly on the fin structures of the first area and the second area (i.e. before masking 11 and etching layer 10 from the second area).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1 – 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wu in view of Frenette et al. (USPAT 5770490, Frenette).

With regard to claim 1:

Wu discloses in figures 6 – 10 a method for forming FinFET devices. Wu discloses in figure 6, figure 7a and paragraph [0019] forming a first fin structure (5), a source region, and a drain region (portions of 5 not covered by gate 9) in a first area of a wafer (1/2). Wu discloses in figure 6, figure 7 and paragraph [0019] forming a second fin structure (6), a source region, and a drain region (portions of 6 not covered by gate 9) in a second area of the wafer. Wu discloses in figure 7b and paragraph [0021] forming a boron silicate glass layer (10) on the first area and the second area. Wu discloses in figure 7b and paragraph [0021] removing the boron silicate glass layer from the second area. Wu discloses in figure 8b and paragraph [0022] forming a phosphosilicate glass layer (12) on the first area and the second area. Wu discloses in figure 9b and paragraph [0023] annealing the first area and the second area, the annealing causing the first fin structure, source region, and drain region of the first area to be doped with boron and causing the second fin structure, source region, and drain region of the second area to be doped with phosphorus. Wu discloses in figure 10 and paragraph [0024] removing the phosphosilicate glass layer from the first area and the second area and removing the boron silicate glass layer from the first area.

As described above, Wu teaches first forming a boron silicate glass layer and then forming a phosphosilicate glass layer. Wu does not teach first forming the phosphosilicate glass layer and then, second, forming the boron silicate glass layer. It

is well known in the art that when simultaneously doping source and drain regions using phosphosilicate glass and boron silicon glass the glass layers may be deposited in any order. Whether phosphosilicate glass is used first or boron silicate glass is used first, this would be recognized by the ordinary artisan as a design choice.

Frenette teaches in figures 2 – 5 and column 3, line 28 – column 4, line 10 wherein either phosphosilicate glass or boron silicate glass can be deposited first (layer 10), and the other glass layer (whichever phosphosilicate or boron silicate is not layer 10) is deposited second 34 when doping source and drain regions (40/42 and 44/46).

It would have been obvious to one of ordinary skill in the art at the time of the present invention to first deposit phosphosilicate glass as layer 10 in Wu and then deposit boron silicate glass as layer 12 in Wu in view of the teaching of Frenette in order to use a design choice that is well understood in the art as articulated by Frenette in column 3, line 28 – column 4, line 10. Further, MPEP 2144.04 IV.C. states that changes in a sequence of adding ingredients is obvious. In this case the ingredients are the glass layers, and Frenette clearly teaches in column 3, line 28 – column 4, line 10 that they may be deposited (added) in either order to serve the same purpose of doping source drain regions.

The combination of Wu with Frenette, wherein layer 10 is phosphosilicate glass and layer 12 is boron silicate glass, will be used when considering the remainder of the claims.

With regard to claim 2, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] and [0022], wherein the forming a phosphosilicate glass layer on the

first area and the second area includes depositing phosphosilicate glass to a thickness ranging from about 100 Å to about 500 Å (the overlapping, disclosed range of 100 Å – 2000 Å anticipates the claimed range).

With regard to claim 3, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] and [0022], wherein the forming a boron silicate glass layer on the first area and the second area includes: depositing boron silicate glass to a thickness ranging from about 100 Å to about 500 Å (the overlapping, disclosed range of 100 Å – 2000 Å anticipates the claimed range).

With regard to claim 4, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] – [0023], wherein the first area is an N-channel area (when layer 10 is phosphosilicate glass).

With regard to claim 5, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] – [0023], wherein the second area is a P-channel area (when layer 12 is borosilicate glass).

With regard to claim 6, the combination of Wu and Frenette teaches in Wu, figure7b and paragraphs [0021] – [0022], wherein the removing a phosphosilicate glass layer from the second area includes masking (11) the first area, and etching the phosphosilicate glass from the second area (when layer 10 is phosphosilicate glass).

Claims 7 – 12 will be considered using the combination of Wu and Frenette similar to the combination of Wu and Frenette used in claims 1 – 6, which, for simplicity, will not be repeated here.

With regard to claim 7, the combination of Wu and Frenette teaches in Wu, figures 6 – 10 paragraphs [0019] – [0023], a method for doping a fin structure and source and drain regions in FinFET devices. The combination of Wu and Frenette teaches in Wu, figures 6 – 7b and paragraphs [0021] and [0023], forming a first glass layer (10) on the fin structure and source and drain regions of an N-channel device (5, in combination) and a P-channel device (6 in combination). The combination of Wu and Frenette teaches in Wu, figure 7b and paragraphs [0021] – [0023], removing the first glass layer from the P-channel device. The combination of Wu and Frenette teaches in Wu, figure 8b and paragraphs [0021] – [0023], forming a second glass layer (12) on the fin structure and source and drain regions of the N-channel device and the P-channel device, the second glass layer being different than the first glass layer. The combination of Wu and Frenette teaches in Wu, figure 9b and paragraph [0023], annealing the N-channel device and the P-channel device to dope the fin structure and source and drain regions of the N-channel device and the P-channel device.

With regard to claim 8, the combination of Wu and Frenette teaches in Wu, figure 10 and paragraph [0024], removing the second glass layer from the N-channel device and the P-channel device, and removing the first glass layer from the N-channel device.

With regard to claim 9, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] – [0022], wherein the first glass layer comprises phosphosilicate glass and the second glass layer comprises boron silicate glass.

With regard to claim 10, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] – [0022], wherein the forming a first glass layer on the N-channel

device and the P-channel device includes depositing phosphosilicate glass to a thickness ranging from about 100 Å to about 500 Å (the overlapping, disclosed range of 100 Å – 2000 Å anticipates the claimed range).

With regard to claim 11, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] – [0022], wherein the forming a second glass layer on the N-channel device and the P-channel device includes depositing boron silicate glass to a thickness ranging from about 100 Å to about 500 Å (the overlapping, disclosed range of 100 Å – 2000 Å anticipates the claimed range).

With regard to claim 12, the combination of Wu and Frenette teaches in Wu, figure 7b and paragraphs [0021] – [0022], wherein the removing the first glass layer from the P-channel device includes forming a mask (11) on the N-channel device, and etching the first glass layer from the P-channel device.

Claims 15 – 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wu as applied to claim 13 above, and further in view of Frenette.

Claims 15 – 19 will be considered using the combination of Wu and Frenette similar to the combination of Wu and Frenette used in claims 1 – 12, above, which, for simplicity, will not be repeated here.

With regard to claim 15, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] – [0022], wherein the first glass layer comprises phosphosilicate glass and the second glass layer comprises boron silicate glass.

With regard to claim 16, the combination of Wu and Frenette teaches in Wu, paragraph [0023], wherein the first area is an N-channel area and the second area is a P-channel area.

With regard to claim 17, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] – [0022], wherein the forming a first glass layer includes depositing phosphosilicate glass to a thickness ranging from about 100 Å to about 500 Å (the overlapping, disclosed range of 100 Å – 2000 Å anticipates the claimed range).

With regard to claim 18, the combination of Wu and Frenette teaches in Wu, paragraphs [0021] – [0022], wherein the forming a second glass layer includes depositing boron silicate glass to a thickness ranging from about 100 Å to about 500 Å (the overlapping, disclosed range of 100 Å – 2000 Å anticipates the claimed range).

With regard to claim 19, the combination of Wu and Frenette teaches in Wu, paragraph [0023], wherein the annealing causes the fin structure in the first area to be doped with phosphorus and the fin structure in the second area to be doped with boron.

(10) Response to Argument

A. Response to arguments with regard to the rejection under 35 U.S.C. 102(e) based on Wu et al.

1. Claims 13 and 14

Appellant has argued that Wu does not disclose or suggest annealing a first area and a second area to dope the fin structures of the first area and the second area. Appellant argues that figure 9B of Wu et al. merely discloses the portion of the FinFET

under PSG layer 12 as a source/drain region 40 and the portion of the FinFET under BSG layer 10 as a source/drain region 30. Appellant argues that this figure in no way discloses annealing the first area and the second area to dope the fin structures of the first area and the second area. Appellant argues that Wu et al. does not disclose doping fin structures based upon the position that a "fin structure" for a FinFET is positioned between the source and drain region. Thus, using this interpretation, appellant argues that the "fin structures" of Wu et al.'s FinFET are only positioned below gate structure 8.

The examiner disagrees with this narrow interpretation of the term "fin structure" as recited in claim 13. Wu et al. disclose doping portions of their fin structures in first and second areas. The portions Wu et al. explicitly disclose doping are the source and drain region (30/40) in each fin (5/6) in figure 9B and in paragraph 0023. But the source and drain regions are part of Wu et al.'s "fin structure." As shown in figure 2 and discussed in paragraph 0016, fin shapes 5 and 6 are formed in the SOI layer 3. The fin shapes 5 and 6 are also shown in top view in figure 3A. The entire fin shape 5 or 6 anticipates the "fin structure" of the claim. Wu et al. refers to the structures 5 and 6 as a "fin shape" (paragraphs 0016 and 0017, for example) or a "FINFET structure" (paragraphs 0018 and 0019, for example). Thus, Wu et al.'s entire "fin shape" or "FINFET structure" teaches the "fin structure" claimed.

Appellant states "as will be appreciated by one skilled in the art, a fin structure for a FinFET device is positioned between the source and drain regions of the FinFET device." This statement is mere speculation on the part of the appellant that does not

rely upon any objective evidence as to what one of ordinary skill in the art would appreciate. Further, the evidence in the file as a whole suggests that one of ordinary skill in the art (at least Wu et al., who are ordinary artisans) would recognize no such thing as the terminology used in the prior art indicates that the entire "fin shape" is part of the "fin structure" and not just a central portion between source and drain regions.

With the term "fin structure" given is broadest reasonable interpretation, as well as the interpretation consistent with similar terms in the prior art, one can clearly see that Wu et al. does indeed disclose annealing the first and second area to dope the "fin structures" of the first area and the second area, as required by claim 13. It is noted that the source and drain regions are a part of the fin structure as a whole and the claim language does not require the entire fin structures be doped such that doping only a portion of the fins reads on claim 13.

Appellant furthers their argument by stating that one skilled in the art would readily appreciate that a fin structure for a FinFET device is positioned between the source and drain regions of the FinFET device. In support of this supposition as to what one of ordinary skill in the art would recognize appellant states that this well-known definition of a fin structure for a FinFET device is depicted in Appellant's figure 3B. This is not persuasive. Appellant's figure 3B shows their structure for a FinFET, not a well-known definition. Further, appellant's figure does not constitute evidence as to what one of ordinary skill in the art, at the time of the invention, would recognize as the definition of a fin structure. Further, the language of claim 13 does not require the fin structure to merely be the portion of the fin located between the source and drain

region. Narrowly interpreting "fin structure" in this manner amounts to improperly reading limitations from the specification into the claims.

Appellant further argues that Wu et al. does not disclose or suggest that the fin structures located between the source/drain regions are doped, as required by claim 13. Claim 13 contains no language requiring the portion of the fin structure between the source and drain be doped, thus this argument is moot.

Appellant also argues that where an explicit definition is provided by Appellant's for a term, that definition will control interpretation of the term as it is used in the claim. Appellant then refers to elements 310 and 320 in figure 3B presumably as their explicit definition of the term "fin structure." The specific example of one fin shape as shown in figure 3B does not constitute an explicit definition. The examiner can find no language in the specification that attempts to specifically define the term "fin structure" and thus no explicit definition has been given to the term in interpreting the claims.

Appellant's arguments have centered on an improperly narrow interpretation of the term "fin structure." If one lends the term it's broadest reasonable interpretation consistent with either its ordinary meaning or its common meaning in the prior art, one can readily see that Wu et al. do properly disclose the claimed invention of annealing the first area and second are to dope the fin structures of the first area and the second area as recited in claim 13.

For arguments sake, even assuming that the term "fin structure" is so narrowly interpreted as to only include the portion of Wu et al.'s fin shapes 5 and 6 that are between the source and drain region (the portion under the gate 8), one of ordinary skill

in the art would recognize that the annealing step of Wu et al. would still dope the "fin structure" as claimed. As one of ordinary skill in the art at the time of the invention would recognize diffusion processes, such as that of Wu et al. paragraph 0023, inherently contain some amount of lateral diffusion. In the diffusion process of Wu et al. the gate 8 and the insulator layer 4 act as a mask so that a channel region will be formed between the source and drain region. However, in this step the dopants will inherently diffuse laterally underneath the mask. This lateral diffusion is a well known property of diffusion. As an example of evidence of lateral diffusion see Wolf et al. pp. 263-64. Wolf et al. shows in figure 12 the contours of diffusion at the edge of a window (mask) and discusses on the first paragraph of page 264 the amount of lateral diffusion that is expected as a percentage of the vertical diffusion depth. This lateral diffusion will result in at least a portion of the "fin structure" beneath the gate being doped during the annealing process of Wu et al. Thus, even using the narrow interpretation of "fin structure" as appellant argues, the claimed method is still anticipated by Wu et al.

2. Claim 20

Appellant has argued that since claim 20 depends from claim 13 it is not anticipated for the reasons previously argued with respect to claim 13. This is not persuasive as the arguments with respect to claim 13 are not persuasive.

Appellant also argues that Wu et al. do not disclose forming the first glass layer directly on the fin structures of the first area and the second area, as required by claim

20. This is not persuasive as Wu et al. clearly discloses this step in figure 7b and in paragraph 0021.

Appellant argues that the first glass layer of Wu et al. is not formed directly on the fin structure that is located below the gate structure 8 and therefore the glass layer is not formed directly on the fin structures. This is not persuasive. This argument again relies upon the incorrect and improper interpretation of "fin structure" as being only that portion of the fin between the source and drain (below gate 8). The examiner has shown that this narrow interpretation is not required by the claim language and that the interpretation of the entire length of fin shape 5 and 6 as the "fin structure" is consistent with the claim language, with the common meaning of the term "fin structure" and is with the meaning of the term as used in the prior art. Thus, under the interpretation of the "fin structure" comprising the entire fin shape 5 and 6, the first glass layer is clearly formed directly on the fin structure. As shown in figure 7B the glass layer 10 is formed directly on the top surface of layer 3 of the fin structure 6. As disclosed in paragraph 0021, the glass layer 10 is formed directly on both fin structures and is subsequently removed from over fin structure 5.

B. Response to arguments with regard to the rejection under 35 U.S.C. 103(a) based on Wu et al. in view of Frenette et el.

1. Claims 1-6

Appellant argues that Wu et al. and Frenette et al. do not disclose annealing the first area and the second area, where the annealing causes the first fin structure, source

region and drain region of the first area to be doped with phosphorus and causes the second fin structure, source region and drain region of the second area to be doped with boron. Appellant argument is based upon the improperly narrow interpretation of "fin structure" that they relied upon previously with regard to claim 13. Appellant again argues that Wu et al. does not disclose or suggest annealing to dope the "fin structure" located between the source and drain and underneath the gate. As explained by the examiner above, this interpretation is not required by the claim language. Appellant has not provided an explicit definition for "fin structure" in their specification. The interpretation taken by the examiner, that the entire fin shape 5 or 6 of Wu et al. is the "fin structure," is considered a proper broadest reasonable interpretation of the claim language. Using this interpretation of "fin structure," Wu et al. with Frenette et al. clearly teach doping the proper dopant (boron or phosphorus) into the first and second fin structure.

Appellant also argues that claim 1 recited three separate elements for the first area and the second area, namely a fin structure, a source region and a drain region in each area. Appellant argues that it is unclear how the source region and drain region of Wu et al. can be considered part of the fin structure when the claim recites three separate elements. First, claim 1 does not specifically recite three separate elements. The claim language does not require the source region and drain region be formed separate from the fin structure, merely that a source *region*, drain *region* and fin *structure* be formed. The claim language also does not preclude the source *region* and drain *region* being integrally formed as regions of the fin structure. The claim language

also does not require separate structures for the source and drain regions, merely that a "region" exist for the source and drain to later be formed in. Wu et al. form a fin structure 5 or 6 that has regions for the source and drain formed integrally therein. Wu et al. then teach doping a portion of the fin structure 5 or 6 to form the source and drain for the NMOS FINFET and the PMOS FINFET. See paragraphs 0019 and 0023, for example. Thus, this doping does indeed dope the fin structure and the source and drain regions in that the source and drain regions are part of the fin structure itself.

Further, assuming for arguments sake that the "fin structure" is a separate element than the source and drain region, specifically the portion underneath the gate 8 as argued by appellant, Wu et al. do inherently teach forming this area (as evidenced by the fact that a portion of fin 5 or 6 exists underneath the gate) and doping this area due to the lateral diffusion of dopants discussed above which is a necessary result of Wu et al.'s annealing/diffusion process. Taking into account the lateral diffusion, at least a portion of the fin structure beneath the gate will be doped as claimed in claim 1.

2. Claims 7-12

The arguments with respect to claims 7-12 are similar to those of claims 1-6, except that claims 7-12 recite an N-channel device and a P-channel device instead of the first area and second area of claims 1-6. The response to these arguments below is accordingly similar to those regarding claims 1-6 except that the first and second area are now treated as the N-channel and P-channel devices, respectively.

Appellant argues that Wu et al. and Frenette et al. do not disclose annealing the N-channel device and the P-channel device to dope the fin structure, source region and drain region of the N-channel device and P-channel device. Appellant's argument is based upon the improperly narrow interpretation of "fin structure" that they relied upon previously with regard to claim 13. Appellant again argues that Wu et al. does not disclose or suggest annealing to dope the "fin structure" located between the source and drain and underneath the gate. As explained by the examiner above, this interpretation is not required by the claim language. Appellant has not provided an explicit definition for "fin structure" in their specification. The interpretation taken by the examiner, that the entire fin shape 5 or 6 of Wu et al. is the "fin structure," is considered a proper broadest reasonable interpretation of the claim language. Using this interpretation of "fin structure," Wu et al. with Frenette et al. clearly teach doping the proper dopant (boron or phosphorus) into the first and second fin structure.

Appellant also argues that claim 7 recites three separate elements for the N-channel device and the P-channel device, namely a fin structure, a source region and a drain region for each. Appellant argues that it is unclear how the source region and drain region of Wu et al. can be considered part of the fin structure when the claim recites three separate elements. First, claim 7 does not specifically recite three separate elements. The claim language does not require the source region and drain region be formed separate from the fin structure, merely that a source region, drain region and fin structure be formed. The claim language also does not preclude the source region and drain region being integrally formed as part of the fin structure. The

claim language also does not require separate structures for the source and drain regions, merely that a "region" exist for the source and drain to later be formed in. Wu et al. form a fin structure 5 or 6 that has regions for the source and drain formed integrally therein. Wu et al. then teach doping a portion of the fin structure 5 or 6 to form the source and drain for the NMOS FINFET and the PMOS FINFET. See paragraphs 0019 and 0023, for example. Thus, this doping does indeed dope the fin structure and the source and drain regions in that the source and drain regions are part of the fin structure itself.

Further, assuming for arguments sake that the "fin structure" is a separate element than the source and drain region, specifically the portion underneath the gate 8 as argued by appellant, Wu et al. do inherently teach forming this area (as evidenced by the fact that a portion of fin 5 or 6 exists underneath the gate) and doping this area due to the lateral diffusion of dopants discussed above which is a necessary result of Wu et al.'s annealing/diffusion process. Taking into account the lateral diffusion, at least a portion of the fin structure beneath the gate will be doped as claimed in claim 7.

3. Claims 15-19

Appellant does not present any further arguments with regard to these claims.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

N. Drew Richards

AU 2815

TOM THOMAS
SUPERVISORY PATENT EXAMINER

Conferees:

Tom Thomas

Drew Dunn